The Bureau of Meteorology

Large-scale blending in ACCESS Numerical Weather Prediction

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Introduction

Large-scale blending (LSB) is a mechanism to apply large-scale information from a (global) parent model into a higher-resolution Limited Area Model (LAM). LAMs can have difficulty correcting the large scales with data assimilation, resulting in comparatively worse performance than a down-scaled forecast in the first few hours.

This method was developed at the Met Office (Milan et al. 2023) and became operational in 2022 in the UK in their regional 1.5km resolution NWP system.

We seek to apply this method to our ACCESS NWP systems. However, new Australia-wide domains are being developed, and LSB has not been tested in such a large domain.

Spinup

Large-scale information is derived from a down-scaled forecast from the parent model. Some spin-up may be beneficial, but small-scale features will be filtered out so are not critical.

The spin-up is assessed by characterising the change in a field over the first few hours (Fig. 1). Most fields reach stability after ~6 hours. However, a shorter forecast starting from a later dump of the parent model should suffice.

2 and 5-hour forecasts are considered. The large-scale increment differs but the information scales are similar (Fig. 2). In this example, a low-pass filter with 700 km threshold is applied.

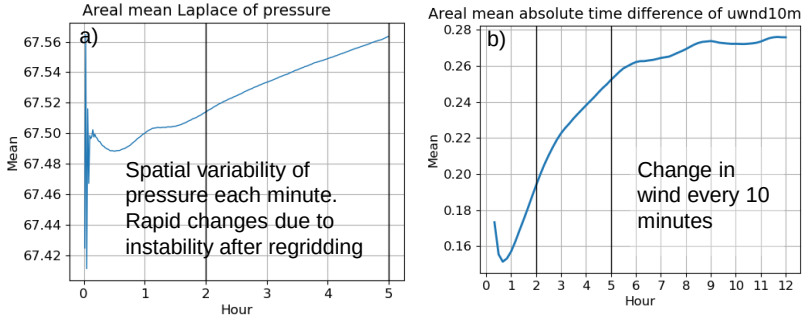

Fig. 1. a) Change in Laplacian of pressure for 1-minute intervals. b) Change in U wind for 10-minute intervals.

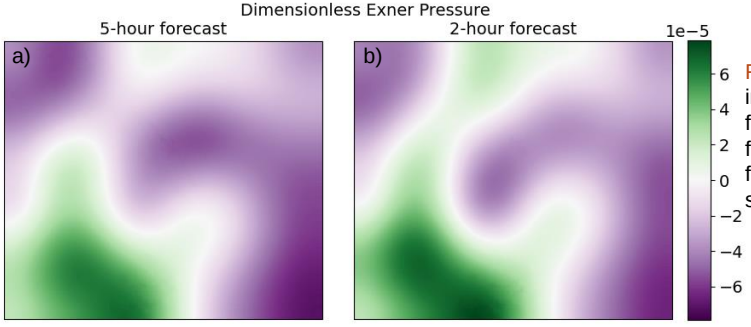

Fig. 2. Large-scale increment derived from a) a 5-hour forecast b) a 2-hour forecast, valid at the same time.

Trialling in ACCESS-C

LSB was trialled for 6 Mar – 8 Apr 2023 with ACCESS-C (Sydney). For practical reasons, 2 hours spin-up was used, with 700 km spatial filtering. Verification against GPM and surface observations is shown (Fig. 3). Fig. 4 shows validation against a global analysis and observed rainfall.

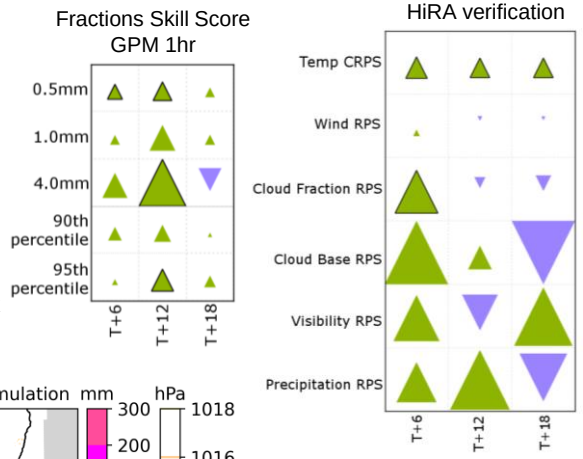

Fig. 3. Verification shows improved surface temperature and precipitation. Black outlines mark significant improvements

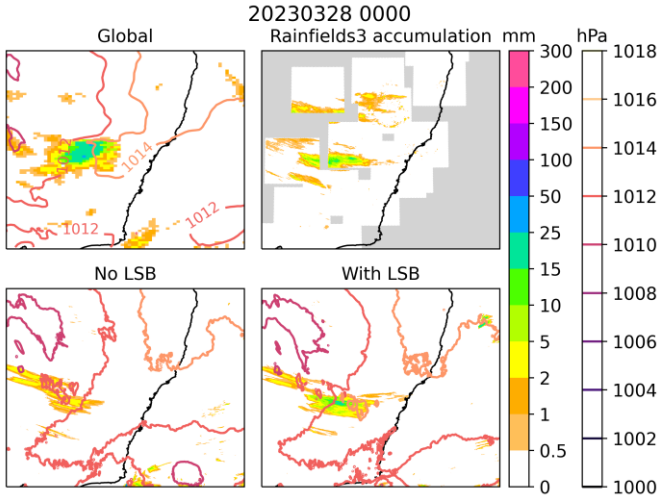

Fig. 4. MSLP and 3-hr accumulated rainfall. Top: global analysis and observed rainfall.
Bottom: Trials with and without LSB. With LSB, the forecast more closely resembles the parent model with improved rainfall intensity and more similar MSLP.

Next Steps

LSB is being implemented in the National Analysis System, and the new ACCESS-A domain that will replace the 7 ACCESS-C domains in future. Trials to determine the optimal configuration will be run.

It is hoped that improving the large scales using information from the parent model, will allow a new focus on data assimilation at small scales.

Reference

Milan, M., Clayton, A., Lorenc, A., Macpherson, B., Tubbs, R. & Dow, G.(2023) Large-scale blending in an hourly 4D-Var framework for a numerical weather prediction model. *QJRMS*, 1–24. https://doi.org/10.1002/qj.4495